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RESEARCH AND IDEAS

Measuring the Real Cost of Ventilation

With the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) putting the final touches on its new residential ventilation standard (ASHRAE 62.2), a lot of designers and builders are wondering how they're going to provide new homes with fresh air at an affordable price.

The measured results from a number of new houses built in Vernon Hills, Illinois, show how adequate fresh air ventilation can be supplied for less than \$175 in installed equipment costs and less than \$30 in annual operating costs. Armin Rudd, a building scientist and inventor with Building Science Corp. (Westford, Massachusetts), did the research under the sponsorship

of the US Department of Energy's Building America Program.

The homes in question were built by Town and Country Homes (Westchester, Illinois) as part of a new 191-unit development called Centennial Crossing (see *EDU*, August 1998). During construction, these large, upscale homes were equipped with a central fan-integrated supply ventilation system. As shown in Figure 1, the system is designed so that the air handler pulls fresh air into the return side of the furnace through a six-inch insulated outside air duct. An adjustable AirCycler control assures that ventilation air will be drawn into the house and distributed even when there's no thermostat

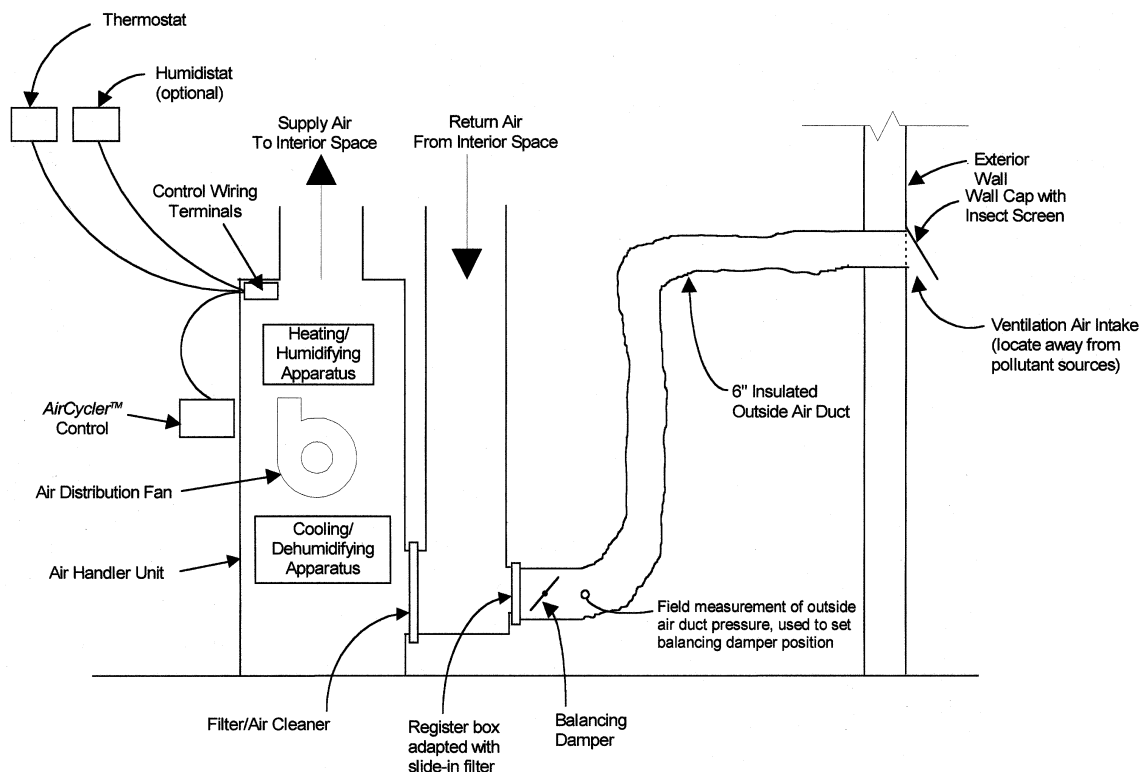


Figure 1 — Central fan-integrated supply ventilation as installed at Centennial Crossing (Vernon Hills, Illinois).

demand for heating or cooling. It does this by using smart logic to operate the fan when the fan has been inactive for a programmable period of time. (See *EDU*, January 2000, for more details on the control.)

Because of concerns in the industry about the operating costs of mechanical ventilation systems, Rudd measured the amount of time that the air handler was running exclusively to provide ventilation. (The rest of the time, ventilation air was brought in and distributed as a “free” byproduct of either heating or cooling.)

In the house located on lot 22, the 350-watt blower consumed just \$21.76 in electricity to meet the home’s ventilation needs over the roughly 10-month test period (see Table 1). These costs, calculated at 8 cents per kilowatt-hour, are for fan energy only and do not include the extra energy that was required to condition incoming fresh air.

The AirCycler in this house was set on a 19% duty cycle — that is, 25 minutes off and 6 minutes on — to provide each occupant with 10 cfm of fresh air per minute via mechanical ventilation. Additional fresh air was supplied incidentally by infiltration through the envelope. “Based on tracer gas testing, we assumed 0.1 air changes per hour as our background infiltration number,” Rudd explains. (Editor’s note: The mechanical ventilation requirement in ASHRAE 62.2 now calls for 7.5 cfm per person, plus 1 cfm for each 100 ft² of floor space, with an infiltration credit set at 2 cfm per 100 ft². (See *EDU*, January 2001.)

As shown in the Table 1, the highest fan electrical costs occurred in the shoulder months of May and October (\$3.06 and \$3.07, respectively). “The controller really shined during those mild months when there was very little heating or cooling demand,” Rudd says. “The reason the fan electricity costs are highest during those months is because the fan is running almost exclusively to draw in fresh air and distribute it. Of course, the occupants also get the benefits of improved comfort due to the whole-house recirculation.”

Rudd tells *EDU* that the AirCycler performed accurately over the test period, with less than a 5% difference between the control setting and the measured duty

Table 1 — Monitored Runtime and Monthly Electrical Costs at 19% Duty Cycle (Centennial Crossing/Lot 22)

| | Cool ON (%) | Heat ON (%) | Fan Recycling | |
|-------------|----------------|----------------|----------------|--------------|
| | | | Vent ON (%) | Cost (\$) |
| Apr (27-30) | 0 | 12 | 12 | 0.24 |
| May | 1 | 2 | 15 | 3.06 |
| Jun | 7 | 1 | 10 | 2.05 |
| Jul | 10 | 0 | 12 | 2.58 |
| Aug | 10 | 0 | 13 | 2.72 |
| Sep | 5 | 0 | 15 | 2.96 |
| Oct | 0 | 4 | 15 | 3.07 |
| Nov | 0 | 13 | 10 | 1.99 |
| Dec | 0 | 20 | 6 | 1.31 |
| Jan | 0 | 31 | 3 | 0.60 |
| Feb | 0 | 23 | 5 | 0.95 |
| Mar (1-9) | 0 | 25 | 4 | 0.23 |

Notes: Fan recycling control set for 25 min OFF, 6 min ON (19% duty cycle)

cycle. Installation costs of the complete system ranged from \$125 to \$175 per house.

Some builders have expressed concern that this type of ventilation system would pressurize the house and drive warm moist air into the walls during the winter, presenting the danger of condensation and moisture problems. But Rudd says his measurements indicate that the house is only pressurized by 0.5-1 pascals and that there’s no more than a 3 pascal pressure difference anywhere in the house. “You don’t have to be really concerned about driving humidity into the walls at those pressure levels,” he concludes. “Besides, our controlled mechanical ventilation system, along with the use of kitchen and bath ventilation, keep the indoor humidity level in check.”

For hot, humid climates in the South, Rudd recommends that the system be complemented with a dehumidifier, not because the ventilation system demands it, but to control humidity year-round independent of thermostat demand for cooling.

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